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The Circumplex Structure of Affective Social Behavior

Dana R. Carney[1] and C. Randall Colvin[2]

Abstract

The authors extended the circumplex structure of emotion to naturally unfolding affective social behaviors. The emotion circumplex describes the circular spacing of emotions and has been harvested from covariation patterns among emotion words, self-reported emotional experience, and judgments of posed facial expression. The distance between emotions is a function of two orthogonal dimensions referred to as valence and arousal. In the present study, 79 participants' 19 affective social behaviors were coded in each of four dyadic social interactions. Confirmatory factor analysis indicated that affective social behaviors exhibited a circular ordering consistent with a circumplex model. Multidimensional scaling provided evidence for the hypothesized two-dimensional valence and arousal factors. Correlations between circumplex factor scores and two personality measures provided validity evidence for the factors. This research is the first to show that naturally occurring affective social behavior conforms to a circumplex structure.

Keywords

emotion, circumplex, social behavior, nonverbal behavior

One of the most robust findings about human emotional experience is that it varies along two dimensions: the valence of the affect (i.e., variation along a good–bad dimension) and the intensity or arousal level of the affect (i.e., low vs. high intensity; see, e.g., Carroll, Yik, Russell, & Feldman Barrett, 1999; Feldman Barrett, 1998; Lang, 1994; Larsen & Diener, 1992; Russell, 1980; Russell & Feldman Barrett, 1999; Watson & Clark, 1997). Many researchers who support the two-dimension perspective agree that affective experience can be described using a circumplex structure consisting of a circular ordering of affective phenomena in which the horizontal and vertical axes are defined by valence and arousal (e.g., Carroll et al., 1999; Larsen & Diener, 1992; Russell, 1980). Over many years, the circumplex structure has emerged from the study of human emotional experience using a variety of methods including similarity judgments of affect terms (e.g., Block, 1957; Russell, 1978, 1980, 1983; Russell, Lewicka, & Niit, 1989; Russell & Ridgeway, 1983), self-reports of current emotion (e.g., Feldman, 1995; Feldman Barrett, 1998; Feldman Barrett & Russell, 1998; Meyer & Schack, 1989; Russell, 1980; Russell & Steiger, 1982), and perceptions of similarity between static photographs of expressed emotion (Abelson & Sermat, 1962; Cliff & Young, 1968; Dittman, 1972; Russell & Bullock, 1985).

A good deal of research suggests that feeling states and emotion concepts do not simply stay simmering in the mind—the body, often automatically and effortlessly, expresses the contents of the mind (e.g., Ekman & Rosenberg, 1997; Spitz, 1997). This idea dates back to William James's (1890) discussion of "ideomotor action." The automatic link between mental activity and bodily expression sometimes even appears bidirectional. One example is research showing that affective body movements such as pushing and pulling can facilitate mental concepts associated with "avoid" and "approach" (e.g., Neumann, Hülsenbeck, & Seibt, 2004). Strack, Martin, and Stepper (1988) showed that unobtrusively expressed smiles (by asking participants to hold a pen between their teeth, which contracted the zygomaticus major, the muscle associated with smiling) activated mental concepts associated with positivity.

In addition to highlighting the link between emotional thought or feeling and related behavior, several studies have demonstrated the automatic link between mental concept activity and concept-consistent behavior (e.g., Bargh, Chen, & Burrows, 1996; Chartrand & Bargh, 1999; Dijksterhuis & van Knippenberg, 1998). As a result, theoretical models that describe the covariation among emotional thoughts and feelings may also apply to the covariation of affective social

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behavior. We tested this supposition by examining whether naturally occurring affective social behaviors could be fitted to a circumplex structure consisting of valence and arousal dimensions. We considered two alternative structures that could provide a good fit for the affective social behaviors: the five factor model (FFM) of personality (e.g., McCrae & Costa, 1990) and Bakan's (1966) two-factor model of agency and communion. The FFM and the agency–communion models both contain highly affective components. Although it was predicted that the emotion circumplex structure would provide the best fitting model for the affective social behaviors, both the FFM and agency–communion models were considered when interpreting results.

The Current Research

To test the hypothesis that the emotion circumplex structure generalizes to affective social behavior, we examined individual differences in objectively coded nonverbal and social behavior naturally expressed during four separate social interactions. To test for circumplexity, we conducted two essential analyses: (a) a confirmatory factor analytic procedure (CIRCUM; Browne, 1992) tested the hypothesized circular ordering of affective behaviors around the perimeter of a circle and (b) a multidimensional scaling (MDS) analysis tested the number of dimensions underlying the covariation among affective behaviors. The validity of the circumplex structure was tested by correlating circumplex-derived factors with two outcome variables.

Method

Participants

Participants were 79 undergraduate and graduate students (43 female and 36 male). To be included in the current study, participants had to attend at least three of the four videotaped interactions. Participants received $20 per completed videotape session. Participants ranged in age from 17 to 33 ($M = 20.60$), and a majority of the sample was White (68.0%), followed by Black (14.0%), Asian or Pacific Islander (11.5%), Hispanic (4.0%), and Other (2.5%).[1]

Procedure and Measures

Participants were videotaped in four dyadic interactions, each of which occurred at least 2 weeks apart. In each interaction, participants were paired with another participant whom they did not know. On two occasions participants interacted with an unknown opposite-sex partner and on two other occasions participants interacted with an unknown same-sex partner. Participants were fully aware that they were being videotaped. For each of the 5-minute videotaped interactions, participants were instructed to "talk about whatever you want and [the experimenter] will be back in 5 minutes."

During a session prior to the first videotaped interaction, participants completed several personality measures. The coding of participants' behavior and the personality measures used in the current report are discussed next.

Coding of affective social behavior. The behavior of all 79 participants in each of the four videotaped 5-minute interactions was coded by a team of trained coders using the 64-item Riverside Behavioral Q-sort (RBQ; Funder, Furr, & Colvin, 2000). The RBQ consists of 64 cards, each one containing a statement describing a specific behavior (e.g., "is reserved and unexpressive"; "shows high enthusiasm") and which is placed into a forced, approximately normal, nine-category distribution ranging from 1 (*not at all characteristic*) to 9 (*highly characteristic*) of the person being coded. Coders watched each interaction twice, after which they sorted the cards into nine piles.

The coders received standardized training in which they were instructed to (a) code behaviors they observed and refrain from making inferences, (b) only code people with whom they were unacquainted, and (c) avoid discussing their ratings with other coders. Each participant in each session was coded by a minimum of four trained coders, and each coder rated a participant only once.

Selection of affective social behaviors. Four judges, each familiar with emotion research, were asked to independently select the subset of RBQ items that contained emotional content. For an RBQ item to be selected, three of the four judges had to agree the item represented an affective social behavior. Overall, judges agreed that 19 RBQ items contained emotional content. These 19 affective items, which compose the affective behaviors used in the current research, are listed in Table 1 (for the entire set of 64 items, see Funder et al., 2000). Interrater reliabilities were calculated for each affective item across the four sessions. As seen in Table 1, they ranged from $\alpha = .42$ to $\alpha = .79$ ($M = .64$).[2]

Participants also completed the Fordyce Happiness Scale (single item; Fordyce, 1977) and the Cook–Medley Hostility Scale (Cook & Medley, 1954; $\alpha = .78$). The measures were used to assess the validity of the circumplex-derived valence and arousal dimensions.

Results

Although much of the previous research on the circumplex structure of emotion has solely relied on MDS, Fabrigar, Visser, and Browne (1997) indicated that MDS scaling approaches do not test the hypothesized circular ordering of items around the perimeter of a circle. Thus, we tested the hypothesized circular ordering of stimuli with a confirmatory factor analytic approach specifically designed to test for circumplexity (the CIRCUM program, by Browne, 1992, is available free from http://faculty.psy.ohio-state.edu/browne/software.php). MDS was subsequently used to verify the hypothesized two-dimensional solution. Finally, to test the validity of the observed circumplex solution, circumplex-derived

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Table 1. Interrater Reliabilities for Each of the 19 Riverside Behavioral Q-sort (RBQ) Items (by Interaction Session and Average Reliability Across Sessions)

RBQ Item	Session 1	Session 2	Session 3	Session 4	*M*
Acts irritated	.73	.68	.59	.73	.69
Acts playful	.64	.70	.72	.61	.67
Appears to be relaxed and comfortable	.74	.67	.62	.56	.65
Behaves in a cheerful manner	.72	.67	.77	.69	.71
Behaves in a timid or fearful manner	.83	.81	.74	.67	.77
Blames others	.39	.62	.20	.21	.37
Expresses guilt	.50	.68	.25	.14	.42
Expresses hostility	.62	.71	.51	.47	.59
Expresses self-pity	.58	.63	.33	.57	.54
Expresses sympathy toward partner	.54	.24	.59	.57	.50
Expresses warmth	.60	.64	.66	.49	.60
Is reserved and unexpressive	.76	.76	.86	.74	.79
Laughs frequently	.79	.77	.78	.76	.78
Says negative things about self	.58	.49	.61	.27	.50
Seems detached from the interaction	.82	.71	.83	.67	.77
Seems to enjoy interaction	.83	.75	.66	.65	.73
Shows high enthusiasm	.77	.76	.78	.71	.76
Shows physical signs of tension	.74	.69	.61	.51	.65
Smiles frequently	.76	.70	.82	.71	.75

Table 2. Predictive Validity of Behavioral Circumplex Factors

External Variable	References	Valence Factor (Higher Is More Positive)	Arousal Factor (Higher Is More Aroused)
Happiness	Andersen (1985); Fordyce (1977); Frank, Ekman, and Friesen (1993)	.25*	.09
Hostility	Cook and Medley (1954); Demaree and Harrison (1997); Dembroski, MacDougall, Herd, and Shields (1979)	–.24*	.22†

Note: Valence is scored such that a higher value indicates more positivity. Arousal is scored such that a higher value indicates more arousal.
† $p < .09$.
* $p < .05$.

factor scores were used to predict two trait variables that are affective: trait happiness and trait hostility.

Testing for Circumplexity With Confirmatory Factor Analysis

We used the CIRCUM procedure (Browne, 1992), a confirmatory factor analytic approach, to test the circular ordering of the affective social behaviors in two-dimensional space. CIRCUM is a DOS-based program that uses a confirmatory factor analytic approach to test the circular ordering of items from an interitem correlation matrix (for a description of the procedure, see Browne, 1992; for published articles applying this procedure to test for circumplexity in emotion and personality, see, e.g., Carroll et al., 1999). In the present research, participants' affective social behaviors were hypothesized to conform to the perimeter of a circle.

Three indices were used to determine model fit, including χ^2, which is traditionally used to test the degree of fit between the hypothesized model and the observed data. Higher values indicate poorer fit. This statistic is heavily influenced by sample size and should be interpreted with caution for samples smaller than 150. It is best used in conjunction with other fit indices that are not influenced by sample size. The RMSEA (root mean square error of approximation; Browne & Cudeck, 1992; Steiger & Lind, 1980) mitigates the influence of sample size in fit assessment and was also used. RMSEA is the fit index preferred by psychometricians because it is independent of sample size and reports 95% confidence intervals. An RMSEA of .05 or less indicates a good model fit. The AIC (Akaike information criterion; Akaike, 1974) was also used to assess fit. The AIC statistic penalizes a model as the number of estimated parameters increases. Smaller values (e.g., below 7.0) represent better fit.

Overall, the circumplex model fit the data fairly well. The χ^2 statistic was statistically significant indicating a poor fit ($\chi^2 = 163.02$, $p < .05$); however, this value was entirely consistent with what has been reported in previous circumplex research (see, e.g., Carroll et al., 1999) and should be interpreted with some caution given its sensitivity to sample size (as noted above). The two other fit indices suggested a very well-fitting model: RMSEA = .05 (confidence intervals put the lower- and upper-bound RMSEA values at .01 and .08; this statistic was also consistent with Carroll et al., 1999) and AIC = 3.56. As

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Figure 1. Graphical representation of circumplex structure of affective social behavior
Note: The vertical arousal axis ranges from low arousal (bottom) to high arousal (top). The horizontal valence axis ranges from negative (left) to positive (right).

predicted, the 19 affective behaviors appeared to fit the circumplex structure. An inspection of Figure 1 illustrates the covariation pattern among the 19 affective behaviors.[3] Adjacent behaviors were likely to be expressed at the same time by participants in a social interaction. In contrast, distant behaviors were less likely to be expressed at the same time. For example, the behaviors "smiling" and "laughing" were fairly closely aligned on the positive side of the circumplex. Thus, "smiling" was much more likely to be accompanied by "laughing" than by "expresses hostility" (which is located on the polar opposite location). Having provided evidence for the circular ordering of affective social behaviors, the next task was to establish the number of dimensions associated with the circumplex structure. MDS was used for this analysis and is presented next.

Testing for Dimensionality With MDS

The MDS approach utilized in previous circumplex research was used to test the prediction that affective social behavior is best described by two dimensions—valence and arousal. First, for each individual participant, a P-correlation matrix was computed on the 19 affective social behaviors averaged across the four observation sessions. The P-matrices were analyzed with the MDS Alscal procedure to determine overall model fit. In this case, MDS used the covariation among behaviors across individuals to determine the number of behavioral dimensions and produced an *n*-dimensional map to illustrate how closely together the behaviors occurred. The MDS solution provided two measures of fit for the *n*-dimensional solution including "stress," in which small numbers indicate better fit, and the amount of variance explained (R^2).

Although a two-dimensional solution was predicted based on prior circumplex models of emotion, alternative models (one-, two-, three-, four-, five-, and six-dimensional solutions) were tested. To determine the best fitting model, the dimensionality of the six models was plotted against each model's stress value (Nosofsky, 1986). The resulting plot is conceptually similar to the scree plot used in factor analysis. The "elbow" in the graph can be inspected to determine the number of dimensions that reduces the stress value while maintaining

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the parsimony of the model. The scree-like plot clearly showed the elbow at the two-dimensional solution, suggesting that two dimensions provided the best fit. Thus, the FFM with five underlying factors was not a viable alternative. The stress statistic indicated a modest model fit at .39, and the two-dimensional solution accounted for 11% of the variance. Although the amount of variance explained appears objectively small, it is unclear whether the R^2 is small relative to those listed in classic reports of circumplex models of affect. R^2 was not reported in the classic report by Russell (1980) nor the reanalysis of the original Russell data reported by Carroll et al. (1999). However, in a meta-analysis of all published meta-analyses ($N = 322$; Richard, Bond, & Stokes-Zoota, 2003), the average effect size in published reports in social psychology is $r = .21$, which is an r^2 of .044. Our two-dimensional model accounted for 11% of the variance, which is larger than the average published result that typically accounts for only 4% of the variance.

Figure 1 depicts the 19 affective behaviors in the two-dimensional Euclidean space. Consistent with predictions and previous research, the vertical axis describes the arousal dimension from low (bottom) to high (top). At the high end of the vertical arousal dimension, behaviors such as ''shows enthusiasm'' and ''acts playful'' can be seen. Behaviors such as ''seems detached'' and ''is reserved and unexpressive'' can be seen at the low end. The horizontal dimension describes the valence property of the behaviors from negative (left) to positive (right). Negative behaviors are items such as ''expresses guilt'' and ''acts irritated,'' whereas positive behaviors are items such as ''laughs'' and ''smiles.''

Overall, the MDS analysis and visual inspection of the two-dimensional map in Figure 1 provide evidence that the valence and arousal dimensions describe two essential characteristics on which the 19 affective behaviors vary. Except for one behavior, the organization of the affective social behaviors in the two-dimensional space is consistent with previous circumplex research. However, the low arousal placement of ''acts timid or fearful'' is arguably problematic because fear is typically considered a moderate to high arousal affective state. However, this aberrant item may have resulted because of the joint wording of ''timid,'' which is a low arousal emotion concept, with ''fearful,'' which is a high arousal emotion concept.

Although the remaining 18 behaviors appear properly placed, empirical evidence is required to determine the validity of the obtained valence and arousal dimensions.[4]

Construct Validity of the Circumplex-Derived Dimensions

To evaluate the construct validity of the circumplex-derived dimensions, the two dimensions of valence and arousal were correlated with two outcome variables: happiness and hostility. The happiness and hostility variables were expected to discriminate between the valence and arousal dimensions. As seen in Table 2, self-reported trait happiness was expected and found to be related to positively valenced behavior (Andersen, 1985; Fordyce, 1977; Frank, Ekman, & Friesen, 1993). Happiness was also expected and found to be unrelated to arousal because general happiness can be either high arousal (e.g., ''excited'') or low arousal (e.g., ''pleasant''; Watson & Clark, 1997). In contrast, hostility is theoretically both a high arousal and a negative construct (e.g., Cook & Medley, 1954; Demaree & Harrison, 1997; Dembroski, MacDougall, Herd, & Shields, 1979). Thus, we expected and found self-reported trait hostility to predict more negatively valenced and higher arousal behavior (e.g., ''blames others'').

Discussion

Affective thought and feeling is expressed through the body. Across both the mind and, in this report, the body, presence and co-occurrence of affect can be described by a simple circumplex with two axes: valence and arousal. That mental life about emotion is expressed in naturally occurring social behavior makes sense given what we know about automatic mind–body connections (e.g., James, 1890; Rizzolatti & Craighero, 2004). The two affective social behavior factors associated with the circumplex model were psychologically meaningful and showed reasonable predictive validity.

Implications for Emotion Theory

Results provide support for both the functionalist and the core affect perspectives. Most emotion theorists would agree there is clearly a symbiotic relation between emotion thought or feeling and behavior. However, proponents of the functionalist perspective take this symbiosis to the level of inextricable necessity, suggesting that human emotional experience is carved up into discrete emotion ''packages.'' An emotion package might include all of the antecedents, unconscious and conscious phenomenology, physiology, brain activation, and behavioral consequences associated with a particular emotional state such as, for example, sadness. Emotion packages are thought to be efficient and adaptive mechanisms for interfacing with the world. Beginning most notably with Charles Darwin (1872/1965) and followed more recently by Ekman (e.g., 1992), emotion packages are thought to have evolved to serve both the self and the social group by appropriately and efficiently responding in communicative expression (e.g., fear) and behavior (e.g., run away!).

The core affect view suggests human emotion is physiologically and phenomenologically divided into basic survival components such as approach and avoid. A slightly enriched version of this view crosses the valence of the affect (good–bad) with the intensity or arousal of the affect (low–high; i.e., the circumplex model of emotion). Although functionalists would agree these basic dimensions underlie affective experience, the two perspectives diverge on whether specific emotion states, such as happy, sad, angry, and fearful, exist as discrete phenomenological and physiological units or whether they are merely labels driven by one's native language in a Whorfian-esque manner. The hardest line of the core affect contingent argues that core affect and its valence and arousal

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properties are felt but that one's language and knowledge of contextual cues fully shape mental representation and resulting labeling of core affect.

Our results suggest some evidence for both perspectives. On one hand, the affective behaviors expressed by the face and body configured into a circumplex pattern that maps remarkably onto similar models of self-reported feeling. If affective expression co-occurs exactly like felt affect, this offers indirect evidence for the functionalist's idea of emotion packages. On the other hand, our behavioral coders used language to map affective labels to participants' behaviors. Thus, it could also be argued that coders' language was in part responsible for conceptualization of participants' behavior given (a) contextual information and (b) coders' knowledge of affective labels likely to accompany specific behaviors. Core affect proponents might argue that coders observed nothing more than core affect varying along the valence and arousal dimensions and then applied labels driven by language and contextual factors. However, the detailed coding method described in this report suggests that this is not likely. Multiple coders reliably rated each social behavior more than once—finely discriminating the behaviors and placing each on a 9-point scale. Given that the coders' primary objective was to evaluate the relative salience of each behavior, and to the extent that several coders independently described the same behavior, it is unlikely that coders' language was able to fully shape their objective observation of presence or absence of a particular behavior. To summarize, the current results do not directly address either perspective but do offer a novel finding showing the circumplex model's applicability to naturally expressed behavior.

How Does This Result Inform Research on Nonverbal and Social Behavior?

Nonverbal and social behavior is sometimes used as an independent variable (e.g., power poses in Carney, Cuddy, & Yap, 2009; unobtrusive smiles in Ito, Chiao, Devine, Lorig, & Cacioppo, 2006; Strack et al., 1988) but is much more often examined as an outcome variable (e.g., smiling less in response to one person vs. another). In this latter type of research, behavior is often studied in discrete or singular units such as smiles, frowns, facial expressions of anger or sadness, head nods, global ratings of friendliness, or hostility. Results reported here suggest that studying meaningful constellations of behaviors acting in unison may provide richer insight into how a person expresses who one is, how one thinks, and what one feels.

Conclusions

To the lexicon of affective stimuli represented by a circumplex, we can likely add naturally unfolding affective behavior. Underscoring the symbiotic link between mind and body, these results support aspects of both the functionalist and the core affect perspectives. These results offer a roadmap for how nonverbal and social behavior might co-occur, which can help us to better understand how nonverbal behavior shapes and is shaped by everyday social cognition and social interaction.

Notes

1. The data reported were taken from a larger study on unrelated questions such as questions about the good judge of personality (Vogt & Colvin, 2003) and accurate assessments of personality (Carney, Colvin, & Hall, 2007; Murphy, Hall, & Colvin, 2003). However, none of the hypotheses tested in the current report overlap with any prior reports based on these data.
2. Although some researchers might regard these data as nested, where each participant is nested within each of three other participants, the complex and randomly assigned nesting structure does not cause interpretational problems because the structure can simply be understood as each participant in four different situational contexts. Because the behavior of each participant is averaged across the four sessions, no one participant's behavior can be attributed to other participants' behavior (because the other participants are simply the context in which the behavior occurred). Thus, we strongly feel that the approach of averaging one person's behavior across four sessions of behavioral expression precludes the possibility that any one person's behavior is a function of another person's behavior.
3. The Euclidean space in Figure 1 was rotated 140° to a target matrix. Item rotation retains each item's relative coordinates to the axes and other items. Rotation is arbitrary and done only to increase the interpretability of the visual plot.
4. In addition, the alternative two-dimensional model of agency–communion also appears to be somewhat represented in Figure 1. The cluster of behaviors in the high arousal negative quadrant appears to represent low communion, whereas the behaviors in the low arousal positive area appear to be high communion. The behaviors clustering in the low arousal negative area appear representative of low agency, and the behaviors in the high arousal positive quadrant appear to be high agency. Thus, we correlated the factors with self-reported agency and communion (agency and communion assessed with the California Adult Q-Set and determined by correlating profiles with prototypes; Block, 1978). Communion was related to positivity ($r = .38$, $p < .001$) and to low arousal ($r = -.25$, $p < .03$). Agency was unrelated to both factors (rs $= -.11$ and .07, respectively). It makes sense that communion, an index of warmth or positivity, is related to both valence and arousal. However, agency was unrelated to both dimensions. Taken together, these results suggest agency–communion is not a viable alternative to our valence–arousal interpretation of the two MDS-derived factors.

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